Preliminary Evidence of Exceptional Growth of Arctic Cod (*Boreogadus saida*) Larvae in the Laptev Sea in 2005

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Introduction

The Arctic cod is a key species in the Arctic marine food web because it channels most of the energy from secondary production to higher trophic levels (e.g. Welch et al. 1992). Fast growth during the first months of life and a large size at the end of summer are believed to be critical for over-winter survival of young Arctic cod and recruitment to the adult population. Early growth depends on several factors such as sea surface temperature (SST), ice concentration, availability of suitable prey at first feeding.

A recent study has shown that survival of Arctic cod larvae is almost impossible when hatching occurs in a period of high ice concentration and below-zero SST (Fortier et al., in press). In many Arctic regions, there is an important annual variability in the timing of the regression of ice cover and of the associated warming of the surface layer. Consequently, in the Northeast Water Polynya, early hatched Arctic cod larvae generally experience massive mortality but may exceptionally show high survival rate during some particularly warm years (Fortier et al., in press). In those years, Arctic cod hatched early have an advantage on those hatched later since they reach a larger size before winter.

The preliminary results of this study suggest that larval and juvenile Arctic cod in the Laptev Sea experienced faster growth in 2005 compared to 2003 or to previous studies in other Arctic regions. This hypothesis is supported by the exceptionally long ice-free season (3-4 months) and very low ice concentration in that year which may have optimized the larval feeding success and growth by allowing an early and intense warming of the surface layer.

Methods

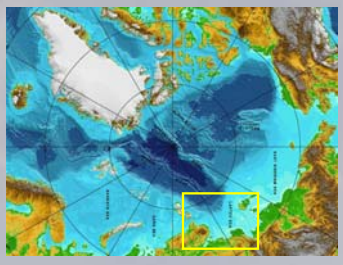

Figure1. Study area. Laptev Sea (Siberian Arctic)

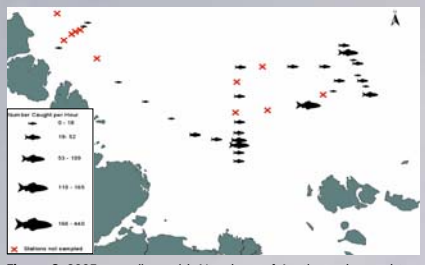

Figure 2. 2005 sampling grid. Numbers of Arctic cod caught at each station standardized for effort

Onboard the icebreaker Kapitan Dranitsyn, young Arctic cod were caught during expeditions of the NABOS program (Nansen and Amundsen Basins Observational System) in September 2003 and 2005 in the Laptev Sea (Figure 1). Numbers of 170 and 424 fish were sampled in 2003 and 2005, respectively (figure 2). Each individual has been measured onboard immediately after capture (Figure 3a). Otolith extraction has been effected for all 2003 fishes and the age (in days) of each individual has been determined by otoliths analysis (Figure 3b and 3c). The linear regression between age and length represents the average growth rate for those fishes (Figure 4).

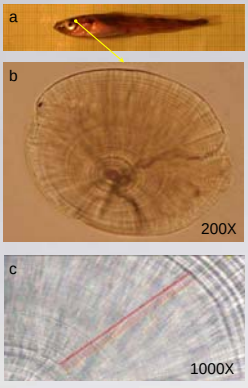

Figure 3. Sample processing. a) fish measurement b) otolith extraction c) otolith analysis

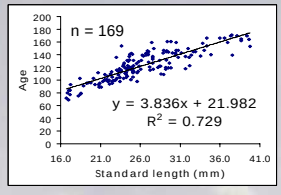

Figure 4. Linear regression between age and length of 2003 Arctic cod

First Results

Otolith analysis of 169 larval Arctic cod (16.7 to 39.8 mm in length) sampled in 2003 revealed an average growth rate of 0.261 mm d^{-1} which is comparable with those found in the Northeast Water (NEW) in 1993 (Fortier et al., in press) and the North Water (NOW) in 1998 (Ringuette et al., in prep). The hatching period extended from March 24th to July 4th 2003 (Figure 5). Using the 2003 age-length regression to back-calculate the age of the 2005 fishes (424 fishes from 14 to 59 mm in length, mean 36 mm) the theoretical hatch season extended from mid-January to early July 2005 (Figure 6). Since the hatching of Arctic cod larvae is known to extend from April to July (to match the plankton production season), this estimated hatch period is unrealistic and suggests that growth in the Laptev Sea in 2005 was much faster (almost 50 % faster) than in 2003, in NEW 1993 or in NOW 1998 (Figure 7). An exceptionally long ice-free season and very low ice concentration in the Laptev Sea in 2005 may have promoted this unexpected growth in larval and juvenile Arctic cod.

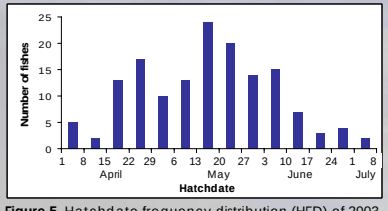

Figure 5. Hatchdate frequency distribution (HFD) of 2003

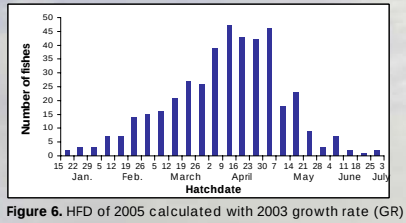

Figure 6. HFD of 2005 calculated with 2003 growth rate (GR)

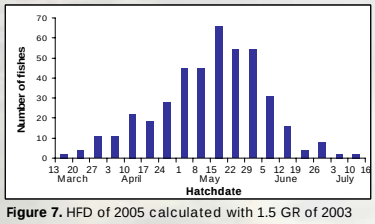

Figure 7. HFD of 2005 calculated with 1.5 GR of 2003

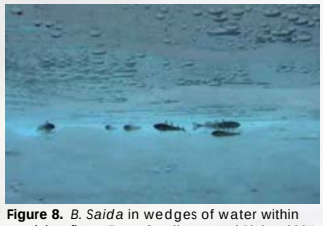

Figure 8. *B. Saida* in wedges of water within pack ice floes. From Gradinger and Bluhm 2004

Conclusion

A warmer Arctic and longer ice-free season could enhance recruitment and enlarge Arctic cod populations, at least in the short term. However, since the species is intimately adapted to life under and inside sea ice, at least during part of the juvenile and adult stage (e.g. Gradinger and Bluhm 2004, Figure 8), it is very difficult to anticipate the response of the species.

Future works

The hypothesis of exceptional growth in 2005 will be verified through the actual aging of the 2005 fishes by otolith analysis. The year 2005 being a record high temperature and low ice year for the whole Arctic, our results will eventually provide crucial insight into the climatic control of early growth that will be useful in modeling the response of this key species to climate change and sea-ice cover reduction.

During the 2006 NABOS cruise, the larval population (survivors and non-survivors that are in open water) and survivors (juveniles that are under sea-ice) will be sampled separately to test the hypothesis of a selection for fast growth among Arctic cod young stages.

References

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